REMARKS

Review and reconsideration on the merits are requested.

Applicants amend claims 1 and 5 fairly based upon the specification at page 18, lines 13-28. See also Invention Specimen No. 9 in Table 1 in which the Mg content of 0.0011 mass% = 11ppm (within the value range of less than 15ppm) is shown.

The Prior Art

JP 2001-214212 (JP '212); U.S. 4,443,254 Floreen (Floreen); JP 56-090,957 (JP '957).

The Rejections

Claims 1-8 under 35 U.S.C. § 103(a) as being unpatentable over JP '212 in view of Floreen and JP '957.

The Examiner's position is set forth in the Action in detail, and will not be repeated here except as necessary to an understanding of Applicants' traversal which is now presented. In this regard, at page 3 of the Action, line 12, it is assumed that the Examiner means to refer to claims 4, 7 and 8, not claims 4, 5 and 6.

Key Aspects of the Present Invention

The Problem To Be Solved

The problem solved by the present invention is how to make nitride inclusions, including TiN and TiCN, and oxide inclusions in a maraging steel fine, where the maraging steel contains not less than 0.3 mass% Ti, and wherein the inclusions are a primary factor which deteriorate the steel and fatigue strength. See the specification, page 10, lines 4-6.

The present invention addresses the above problem as follows.

First, a consumable electrode is produced from a melt of the maraging steel where Mg has been positively added to the melt to form MgO type oxide. Since agglomeration of MgO type oxide is weaker than that of alumina, the obtained oxide inclusions are fine, noting that each of the nitride inclusions grows on the MgO type oxide which serves as a nucleus for growth. See page 8, lines 5-7 of the present specification.

In a second step, the consumable electrode is melted under vacuum. During melting the steel under vacuum, Mg which is formed as the MgO type oxide vaporizes, whereby oxide inclusions are decomposed to generate oxygen which diffuses into a gas phase and a liquid phase so that oxide inclusions are reduced. Although a part of the oxygen diffuses into the molten steel to generate fresh oxide inclusions, such oxide inclusions are fine because the melting process is carried out under vacuum. See the present specification at page 8, lines 16-26.

To obtain such an inclusion-refining affect, it is necessary for Mg to remain in the consumable electrode in an amount of not less than 5ppm. The quantity of Mg is reduced by the above remelting process under vacuum. Applicants respectfully submit that such an inclusion refining process which involves two-steps is novel and unobvious over the prior art.

With respect to claim 5, and unique metal structure having a peculiar oxide inclusions can be obtained by **remelting the consumable electrode containing Mg under vacuum**.

The Prior Art

None of the prior art teach the inclusion refining process of the present claims. Further, Applicants also submit that it is novel and unobvious to cause Mg to remain in the consumable electrode to be remelted.

JP '212

(a) JP '212 contains no disclosure regarding Mg. The Examiner appreciates this is the case. Action, page 4, last full paragraph (2 lines).

(b) The inclusion refining method of JP '212 can be described as follows: A raw material of a Ti-containing steel which contains no TiN inclusions is used (see claim 1). Specifically, pure Ti, pure Ni, ferro-molybdenum, pure copper, pure aluminum and electrolytic iron are used as the raw materials.

(c) The production process disclosed in JP '212 can fairly be described as follows: The raw material is melted by VIM (Vacuum Induction Melting) to obtain an ingot as an electrode. The electrode is remelted by VAR (Vacuum Arc Remelting) or ESR (Electro Slag Remelting) to obtain an ingot. The latter ingot is subjected to forging and subsequent hot rolling to produce a steel plate having a thickness of 3.5 mm.

It is to be specifically noted that the inclusion refining method of JP '212 is performed by excluding inclusion-forming substances throughout the production process of JP '212, including the first step of the JP '212 process, and this is done by utilizing pure materials and by using VIM and VAM, whereby the formation of inclusions in the melt can be avoided. In the maraging steel of JP '212, only metal elements which improve the toughness and strength of the steel are added. In distinction, in the method of the present invention, Mg is positively added into the steel to form MgO type oxide inclusions during melting for producing the consumable electrode. The additive Mg amount should be **sufficient to form a substantial amount of MgO in the consumable electrode. The thus formed MgO (which is a temporary inclusion) is**

decomposed in the following step of vacuum remelting, whereby one finally obtains fine non-metallic inclusions in the maraging steel. This is a new and unique steel producing process. The obtained product has a peculiar metal structure as claimed in claim 5.

Floreen

As the Examiner appreciates, see Action, paragraph bridging pages 4/5, line 1 and Action, paragraph bridging pages 5/6, line 1, Floreen discloses a cobalt-free maraging steel.

Floreen specifically discloses at col. 3, lines 11-16 as follows:

> "With regard to processing, air melting practices can be employed though it is preferred that vacuum melting, e.g., vacuum induction melting, be used. This can be followed by vacuum arc remelting. Zirconium, boron, calcium, and also magnesium can be used for deoxidizing and/or malleabilizing purpose".

(a) With respect to Mg, Floreen discloses that Mg can be added in an amount of not more than 1% (column 2, lines 19-20) (but, up to 0.25% according to claim 3: column 5, lines 9-10) for the purpose of deoxidizing and/or malleabilizing. Mg is one of the elements of a group consisting of Zr, B, Ca and Si.

(b) With respect to the inclusion refining method disclosed in Floreen, Floreen is completely silent on the inclusion refining method used.

(c) With respect to the production process disclosed in Floreen, VIM and subsequent VAR are preferred (see the above quotation from col. 3, lines 11-16 of Floreen). At col. 3, lines 27-31, Floreen discloses that a bar of cobalt-free maraging steel having a size of 2" x 2" was produced using VIM (vacuum induction melting), soaking and hot rolling.

It is to be specifically noted and appreciated that the Floreen invention is not directed to refining inclusions in steel. An optional amount of Mg is added to the steel for the purpose of deoxidizing and/or malleabilizing. Specifically, as a deoxidizer Mg is simply added into the steel in order to reduce oxygen in the melt during a primary melting process. It is thus quite unnecessary for an ingot cast from the melt produced by the primary melting process of Floreen to contain residual Mg.

With respect to any mechanism regarding the malleability of steel, Floreen is simply silent. Applicants believe that according to common knowledge in the art, Mg as an additive can fix impurity sulfur which deteriorates steel in malleability. When sulfur is fixed by Mg in a primary melting process as in Floreen, the ingot obtained (or electrode to be subjected to VAR) will contain MgS. **If the ingot or electrode is remelted under vacuum**, the MgS is decomposed and the Mg formed vaporizes so that sulfur remains in the molten steel during remelting under vacuum. Further, the sulfur would also remain in an ingot cast from the remelted steel. In this case, remelting would be totally illogical because the final steel product would contain free sulfur which deteriorates malleability. Thus, contrary to the Examiner's conclusion, Applicants respectfully submit that rather than suggesting combination with JP '212, Floreen would teach one of ordinary skill in the art against combination with JP '212.

In summary, it is unnecessary for Mg as a deoxidizer to remain in an ingot after primary melting, and VAR (secondary melting) would be unnecessary or in fact inadvisable when Mg is used for the purpose of malleabilizing.

Thus, there would be no reason to modify JP '212 in Floreen as urged by the Examiner.

JP '957

JP '957 discloses a maraging steel which shows excellent stress corrosion cracking resistance.

(a) With respect to the disclosure in JP '957 regarding Mg, it can fairly be characterized as follows: Mg can be added in an amount of not less than about 0.001% for the purpose of improving stress corrosion cracking resistance of the steel. More specifically, one or more elements of the group consisting of Mg and Ca is/are added in an amount of not less than about 0.001% for the purpose of improving stress corrosion cracking resistance of the steel. See page 3, at the upper left column. On the other hand, it is stated in claim 1 that one or more elements of the group consisting of Mg and Ca are added in a total amount of not less than 0.001% to 0.1%.

(b) With respect to the inclusion refining method used, JP '957 is completely silent on this subject.

(c) With respect to the production process used, JP '957 contains no disclosure on vacuum or melting. According to one embodiment disclosed in JP '957, a maraging steel plate having a thickness of 1 mm was produced through melting, hot working and cold working. See page 3, lower left column.

The following points are to be specifically noted.

From the disclosure of JP '957, one of ordinary skill in the art would understand that VAR is unnecessary when sulfur is fixed by Mg, as is the case with Floreen.

As importantly, Mg can be added to the steel in order to improve stress corrosion cracking resistance of the steel. With regard to the stress corrosion cracking resistance, Applicants advise JP '957 states that:

> "occurrence of the environmental embrittlement of maraging steel is not due to the hydrogen embrittlement which can be found often in high tension low alloy steels but due to the active path corrosion which can be found in austenitic stainless steel, copper alloys and so on, and which is the stress-corrosion cracking according to the narrow definition." See JP '957, page 2, the upper left column.

From this disclosure in JP '957, one of ordinary skill in the art would understand that active melting is prevented by the additive Mg. Specifically, the prevention of active melting can be achieved by preventing segregation of sulfur at grain boundaries. Such segregation can be prevented by fixing sulfur by means of the additive Mg. In the case of fixing sulfur by means of the additive Mg, remelting under vacuum would not be carried out as one of ordinary skill in the art would instantly appreciate that such remelting would cause MgS to be decomposed, resulting in free sulfur. One of ordinary skill in the art would not be led to use such a procedure and, as a consequence, one of ordinary skill in the art would not be led to modify JP '212 in view of JP '957.

The Combination of References

In the method of JP '212, inclusions are excluded from the raw materials, and VIM and VAR are used as melting processes in order to generate no inclusions in the steel. In such a method, one of ordinary skill in the art would not consider using the additive Mg which enhances the generation of inclusions because of its high affinity with oxygen. See the above discussion regarding Floreen and JP '957. In Floreen, when Mg is added for its deoxidizing function, it is

unnecessary for the Mg to remain in the steel after primary melting. Further, in both Floreen and JP '957, when Mg is added to fix sulfur, it is not only unnecessary but one of ordinary skill in the art would find it inadvisable to perform remelting under vacuum.

In short, one of ordinary skill in the art would not consider combining the teachings of JP '212, Floreen and JP '957.

Request for Telephone Interview

A telephone interview is requested concerning this application.

The undersigned can be reached at the later given telephone exchange.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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